which he had had an opportunity of examining. He did not obtain even this modest instrument until May 1638, about a year before Milton viewed the moon through "the optic glass" of "the Tuscan artist":—

> "At evening from the top of Fesole,
> Or from Valdarno, to descry new lands,
> Rivers or mountains in her spotty globe."

The "mute inglorious Miltons" of Toxteth seem not to have been wholly incurious respecting the researches of their fellow villager, who speaks in another letter of having endeavoured to exhibit Venus in her crescent phase to "sundry bystanders," who however were unable to discern the phenomenon owing to their inexperience in the use of the instrument. The possession of a telescope may have stimulated his desire to become acquainted with the writings of its inventor. Four months later we find him possessed of Galileo's dialogue on the "System of the Universe," and anxious to procure his "Nuncius Sidereus," and treatise on the Solar Spots. He had previously speculated upon the exact period of the creation of the world, which he sought to determine by a combination of astronomical and scriptural data; and upon the origin of comets, which he supposed to be emitted from the sun. The phenomena of the planetary aphelion and perihelion had likewise engaged his attention, and elicited remarks which almost seem prophetic of the great discovery of Sir Isaac Newton. In observing the setting sun he had noticed a raggedness of the margin, which he rightly attributed to atmospheric conditions. During the last three months of his life, when unable to bestow time on astronomical research, he commenced an attentive study of the irregularities of the tides, from which he hoped to obtain a demonstration of the rotation of the earth. The Lancashire coast, where the recess of the tide is very considerable, is highly favourable to similar observations.

(*To be continued.*)

CARUS'S HISTORY OF ZOOLOGY

Geschichte der Zoologie bis auf Joh. Müller und Charles Darwin, von J. Victor Carus. Pp. 739. (München, 1872.)

TWO of the most characteristic qualities of the present time are scepticism and sympathy; and by a happy combination of the ability to investigate statements instead of taking them on trust, and the power of realising past states of knowledge and of feeling, a most important advance has been made in history. But the historical method is not confined to what is commonly so called. It has been applied to philology and philosophy, and has reformed both, while even in the physical sciences its importance is now fully recognised. It is true that a science like Zoology, which deals entirely with objective facts, is more independent of history than some others, and its history does not really begin till the seventeenth century. But as part of the history of the human mind, it will always be important to study the sciences of pre-scientific ages, and when we meet with such a master-mind as that of Aristotle, whatever he wrote becomes of the highest interest because it was his.

The work before us, by the son of the late eminent zoologist of the same name,* is one of the series undertaken by command of the late King of Bavaria, and published by a Historical Commission of the Royal Academy of Sciences in Munich. It embraces the history of the whole body of science in Germany, and the volumes which have already appeared have been written by men of high eminence in their several departments.

Fortunately, however, Prof. Carus does not at all confine himself to Germany, so that the present work is an attempt at a complete history of zoology, from the earliest to the present time. It naturally divides itself into two parts, the first treating of what may be called pre-scientific zoology, which is only of general historical interest, the second tracing the development of zoology, as a science of observation and experiment, from its foundation by Ray and Linnæus. These two sections are handled on a very different scale, for the former occupies more than half the book, and is therefore sufficiently minute, while the whole history of modern zoology is compressed into three hundred pages. The consequence is that, while accurate as to facts, the latter part is often little but a list of names and dates.

We shall therefore simply direct the attention of zoologists to the second portion of Prof. Carus's history as convenient and well-arranged for reference, and dwell here on his detailed account of the less known progress made in ancient and mediæval times towards a knowledge of the varieties and structure of animals.

The first chapter treats of the earliest animals known to man, including those domesticated in prehistoric times. The names of the Ox, Sheep, Goat, Pig, Dog, Horse, and Goose, occur in allied forms in most of the Indo-European languages, and their bones are found among the dust-heaps of the earliest race of men known. The Cat (αἴλουρος), though domesticated in Egypt, was not a household animal till much later in Western Europe: the "cat" of the Greeks and Romans (γαλῆ) being almost certainly the whitebreasted beech-marten (*Martes foina*) a conclusion learnedly and perspicuously established by Prof. Rolleston in a paper published in the *Journal of Anatomy and Physiology*, for November 1867. But the Flea and the Louse appear to have been familiar from the earliest times, and Mice, Flies, and Worms are also among the first named by man. To the same primitive group belong the Bear, the Beaver, which lived in English rivers up to comparatively recent times, and the Wolf and Fox, the names of which (*vulpes*, Wolf) have evidently been confounded.

After a short account of the part taken by animals in early mythology and in the fables common to the Indo-European nations—a chapter which might have been with advantage enlarged from the pages of Grimm, Dasent, and Link—our author enumerates the domestic animals known in classical times, which include, beside those already mentioned, the Camel (confounded with the elephant during the Middle ages), the common Fowl (ὄρνις περσική Aristoph., Av. 485), which was introduced from the East between the date of Homer and Hesiod and that of Æschylus, the Chenalopex, probably identical with our sheldrake (*Tadorna vulpanser*), pigeons of various breeds, and birds of prey which were used for hawking. The list of wild animals was greatly increased by the games of the Roman circus, and many, like the Hippopotamus, Rhinoceros, and Giraffe were better known under the Empire than they have been until very recent times. Pliny mentions the occurrence of the Platinista in the Ganges, but no notice of the Hyrax, a form so familiar to the Hebrews, is to be found in Greek or Roman authors.

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* The accomplished author himself is now lecturing in Edinburgh as Prof. W. Thomson's substitute.

The next sections are occupied by a tolerably full account of the knowledge of anatomy and physiology possessed by Aristotle, and by his successors, Herophilus and Erasistratus, and of the attempts made towards a classification of the animal kingdom. The groups recognised by the first, and perhaps the greatest, of naturalists, are surprisingly near to what are now accepted. 1. Viviparous quadrupeds, clothed with hair (*ζωοτόκα τετράποδα*)—Mammalia, exclusive of Cetacea. 2. Birds (*ὄρνιθες*) exclusive of bats. 3. Oviparous quadrupeds, inclusive of snakes and frogs. 4. Cetacea (*κήτη*), with teats and milk (Hist. An., iii. 99). 5. Fishes (*ἰχθύες*). Those with (red) blood are distinguished from the remaining "bloodless" classes. 6. The Cephalopodous mollusks (*μαλάκια*). 7. The testaceous mollusks, including ascidians, cirripedia and echinidæ (*’οστρακόδερμα*). 8. Malacostraca—Crustacea. 9. Insecta (*ἔντομα*) including all air-breathing Arthropoda. Lastly, Starfishes, Sponges, and some other groups, are characterised as partaking of the nature of plants (Zoophyta).

On the whole, Aristotle's zoology is less imperfect than his anatomy. In spite of Prof. Carus's opinion, the well-known passage (Hist. An. i. 39) clearly states what is repeated in two other passages, that the back of the skull is empty, and his views of the position and functions of the heart, lungs, and nerves are scarcely more scientific than Plato's notions of hepatic triangles. Indeed it is difficult to believe that Aristotle can ever have completely dissected a single mammal. The digestive and reproductive systems he understood much better. But beside his wonderful industry in collecting facts, the acuteness and power of generalisation displayed by Aristotle in other branches of science are not wanting in natural history. Thus he remarks that insects with horny wings have no sting. "I have never seen an animal with solid hoofs and two horns." When horns are present there are no canine teeth. Quadrupeds which bring forth their young alive are clothed with hair, those which lay eggs, with scales. Insects with four wings have the sting behind, those with two, in front. Nor is it the least proof of Aristotle's greatness that he gave an impetus to biological science which produced the Alexandrian school of anatomy, and only ended at the beginning of the third century of our era with the death of Galen.

The contributions of Roman authors to zoology, such as those buried in the huge mass of crude and chiefly worthless material which Pliny called natural history, only mark the decay of the science. During the subsequent dark ages (the darkness of which is probably for the most part subjective) the most remarkable work on zoology is the famous "Physiologus," also called the "Bestiarius Theobaldi," of uncertain authorship and date, but known over the whole of Christendom from the eighth to the thirteenth century by translations into Syriac, Armenian, Arabic, Ethiopic, German, English, Icelandic, and French. The Greek text is probably the original, from which the Latin was taken. This long-forgotten book, like Pliny's, includes accounts of plants, stones, and other natural objects, and describes among more common-place animals, mermaids, unicorns, and onocentaurs. There are mentioned, of quadrupeds, the antelope (perhaps the Urus), beaver, elephant, hyæna, monkey, and lion, beside common European species; thirteen species of birds, including the ostrich; of reptiles, several kinds of lizards, and serpents, but only one invertebrate animal, the ant. The original plan appears to have included only the animals mentioned in the Bible, and the chief object of the book is to draw moral lessons from the habits of the creatures described. The "Physiologus," while of great historical interest, is, of course, devoid of even relative scientific value.

Passing over the Arabian naturalists, who added little original, we come to the three writers who represent the science of the Middle Ages when the writings of Aristotle became generally known and the systems of scholastic philosophy were founded—Thomas of Cantimpré, Albertus Magnus, bishop of Ratisbon, and Vincent of Beauvais. They were all Dominicans, and all belong to the thirteenth century, that remarkable era of revolution in philosophy, politics, and art. At this time knowledge of foreign animals was greatly increased by the travels of Marco Polo (1275–1292), who described the wild horses, musk deer, and yaks of Tartary, the camels and asses of Persia, and the rhinoceroses, elephants and tigers of India.

Museums only began to be formed in the sixteenth century when the discovery of America brought to light so many new animals and plants; but for a long time they were what museums still too often are, mere lumber rooms of "Dinge gantz seltzam und fremdt," as Duke Albert of Prussia wrote in 1559. All the earliest anatomical preparations, including the celebrated dissections of Harvey still preserved in the College of Physicians, are dry.

The *Lucidarius*, a medley of stories about animals, which represents in the Renaissance what the Physiologus does in the Middle Ages, appeared in 1479, and like the latter was translated into all the European languages.

The earliest attempt at a System of Zoology was by Wotton in his *Differentiis Animalium*, published at London in 1550. It is little more than a reproduction of the doctrine of Aristotle. Conrad Gesner's *Historia Animalium* appeared in 1551. Like Wotton, he was a physician, and practised in Switzerland and South Germany. His work is chiefly remarkable for its illustrations, one of which, the figure of the Rhinoceros, was drawn by Albert Dürer. Passing over the names of Aldrovandi (1522-1603), Johnston (1603-1675), and Sperling (1603-1661), the next important work on zoology was Bockart's *Hierozoicon*, published in 1663. This work of the learned Norman Huguenot has been a quarry which succeeding biblical commentators have continually used, but its value is almost entirely literary: indeed it was written rather as a contribution to hermeneutics than to natural science. The figures in a work of Clusius, "Exotica," which belongs to the early part of the seventeenth century, show by those of the sloth, the manatee, the armadillo, humming-bird, cassowary, dodo, penguin, and molucca crab, how much the discoveries made in America, Madagascar, and New Holland, were increasing the list of known animals.

During the first half of the seventeenth century there also appeared the earliest monographs. Thus Nicholas Tulp, the anatomical lecturer in Rembrandt's famous painting at the Hague, gives a description and an admirable engraving on copper of what he calls an "orang-outang," evidently a chimpanzee from Africa; and in the same *Observationes Medicæ* (1641) figures a narwhal as "Unicornis marinus." The *Libellus de Canibus Britannicis* (dedicated to Gesner), of our countryman John Kay (Caius) was earlier than Tulp's papers. It was followed by monographs on the elephant by Lipsius and Caspar Horn, on the stag, with an account of its dissection, by Agricola, of the hippopotamus, from a specimen sent in brine from Damietta to Rome, by Columna, and of fishes in general by Salviani and Rondelet. In 1634 was published at London *Insectorum theatrum*, avowedly founded on the words of Wotton and Gesner, and on a compilation from both which had been begun by Thomas Penn, and interrupted by his death; the next editor was Thomas Mouffet, but he also died several years before it was published. This is a noble monograph, with woodcuts so accurate and characteristic as to compare with the best productions of modern skill. It is also remarkable for containing a full and correct account of the *Acarus scabiei*, which was afterwards so long forgotten. Beside insects (in the Linnæan sense of the word) it describes worms of various kinds, and among them what is apparently a *Bothriocephalus latus*. This species is still more distinctly figured by Tulpius (Obs. Med. tab. vii), but by some strange error it is represented with two heads. Spigelius (*de lumbrico lato*) gravely discusses whether it is an animal at all.

Meantime anatomy and physiology were making rapid progress. Vesalius (1514-1564), the father of modern anatomy, and his contemporary Eustachius, who ventured to oppose his own dissections to the authority of Galen, Fallopius, and his successor at Padua, Fabricius, and the still more illustrious pupil of Fabricius, William Harvey, form a succession of almost unequalled eminence. The dissections of our countryman Thomas Willis (1621-1675) were not confined to human subjects, and the earliest microscopical observations, by Malpighi, Leeuwenhoek, and Hooke, were also to a large extent zoological. After the middle of the seventeenth century the three most illustrious scientific societies were founded, the *Academia Naturæ Curiosorum* (1652) incorporated as the "Leopoldinisch-Carolinische Academie" in 1677, the Royal Society in 1662, and the Académie des Sciences four years later. In 1667 Ray was elected a Fellow of the Royal Society, and began the series of papers which mark the first steps of scientific zoology, and surely prepared the way for his greater successor Linnæus. P. H. PYE-SMITH

OUR BOOK SHELF

Lehrbuch der Physik. Von Dr. Paul Reis, Zweite Lieferung, Leipzig. (Quandt and Bäudel, 1873.)

THE second part of this useful handbook of physics opens with the explanation of Mariotte's Law and the various applications of atmospheric pressure. The next division is devoted to the study of wave motion, which is discussed far more fully than in the ordinary run of scientific text-books. This leads on to acoustics, and we are at once plunged rather abruptly into the subject of musical intervals. The theory of consonance, the cause of the intensity of sound and its mode of propagation make up the novel arrangement of this chapter. Optics occupies the sixth division, and is carefully treated. Especially noteworthy is the chapter on the theory of the absorption and dispersion of light, in which there is an excellent account of spectrum analysis. The part before us breaks off in the discussion of physiological optics, where Helmholtz's researches are in part developed. It is a pity that the engravings are not equal to those generally found in continental text-books.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Jacamar in Britain

I SEE, in your review of Mr. Cordeaux's "Birds of the Humber District," mention of a Jacamar—I presume a Galbula—having been shot by a keeper named S. Fox, near Gainsborough, in 1849. You and the author, Mr. Cordeaux, naturally remark on the "extraordinary" puzzle of the fact.

As one who has often seen the Jacamar in its own tropic forests, and watched its flight and its feeding, I must be allowed to suspect some mistake, unless the most "startling"—in every sense of the word—evidence of the authenticity of the specimen is given.

Ready to believe everything, in such a world of wonders, I might have believed in a Jacamar being blown to south-west Cornwall, Ireland, or Scotland. But in the eastern counties—"Qu'allait il faire dans ce galere là ?"

Harrow, June 6 C. KINGSLEY

The Use of Wires in Correcting Echo

[The following letter has been forwarded to us by Mr. J. J. Murphy]:—

Palace, Cork, May 30, 1873

My Dear Mr. Murphy,

Having seen in the newspapers some notices of the use of wires for correcting the echo by breaking the waves of sound in churches and public buildings, we were anxious to try the experiment in the cathedral of St. Fin Barre, Cork, the nave of which is of great height, between 60 and 70 feet, and narrow in proportion to its height. We were unable to obtain any reliable information as to the placing of the wires, so that what we did was very much in the way of experiment. I should state that the desks for the officiating clergy and the choir are placed at the intersection of the transepts, nave, and chancel, so that this may be regarded as the point from which the sound starts. The organ is placed in a gallery at the west end, and the organist seated in this gallery has always heard much more distinctly than the people sitting about two-thirds down the nave, particularly those close to the pillars; but the echo seemed to render the sound indistinct, more especially in the transepts, the north and south walls of which presented a large flat surface, and appeared to us to be probably the source of the echo.

At first we tried the wires strained at a considerable height, the level of the triforium, but they produced comparatively little effect; we then strained a double course of wire at about a height of 12 or 15 feet round the large piers of the central tower, so as to encompass the choir, and other wires completely across the nave and side aisles, and the effect was certainly very good. There was a greater distinctness of sound throughout the building. Our organist, who is a very accomplished musician, did not know that the wires were put up, and remarked to me one day after service that he did not know what it was, but that everything seemed to him in better tune.

This encouraged us to make further experiments. We then strained three wires completely across from the south wall of the south transept to the north wall of the north transept, so as to pass over the heads of the choir, but the effect was quite too great, it seemed to kill the sound, every sound seemed to stop at once, all resonance was gone. These wires we had at once to take down, and I should add that, as regards the organist, the wires over the heads of the choir seemed to produce a much greater effect than those directly between the choir and his